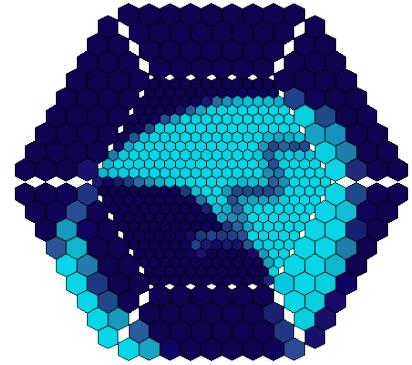




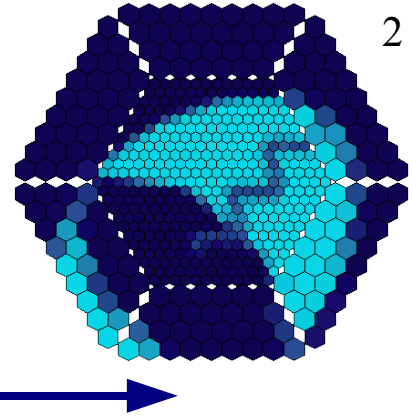
Thomas Bretz



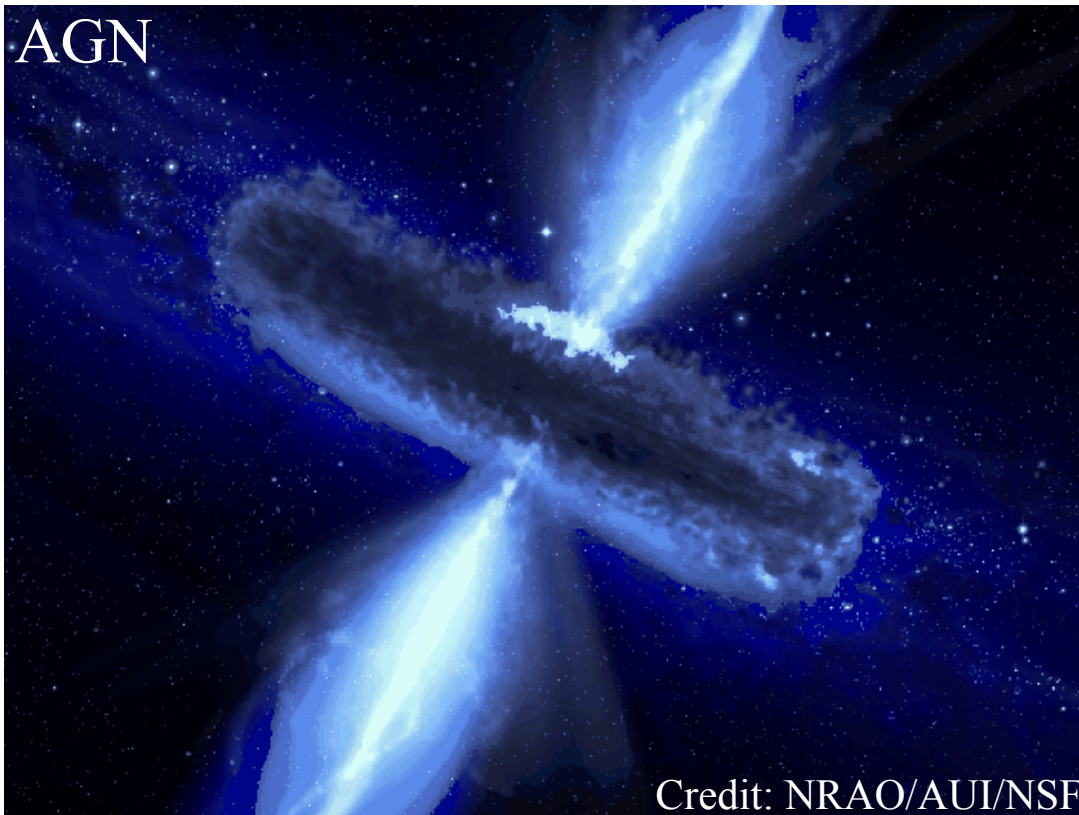
The DWARF – Project says:  
*„Hyvää Päivää“*



# Goal

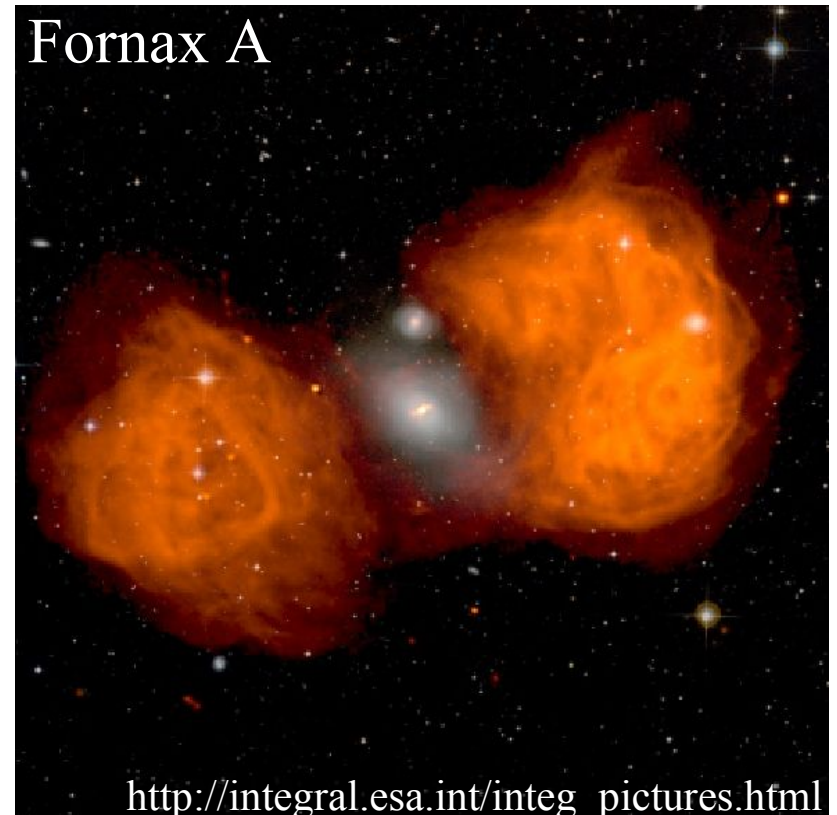


...is long-term monitoring of AGNs...



Credit: NRAO/AUI/NSF

Artistic view

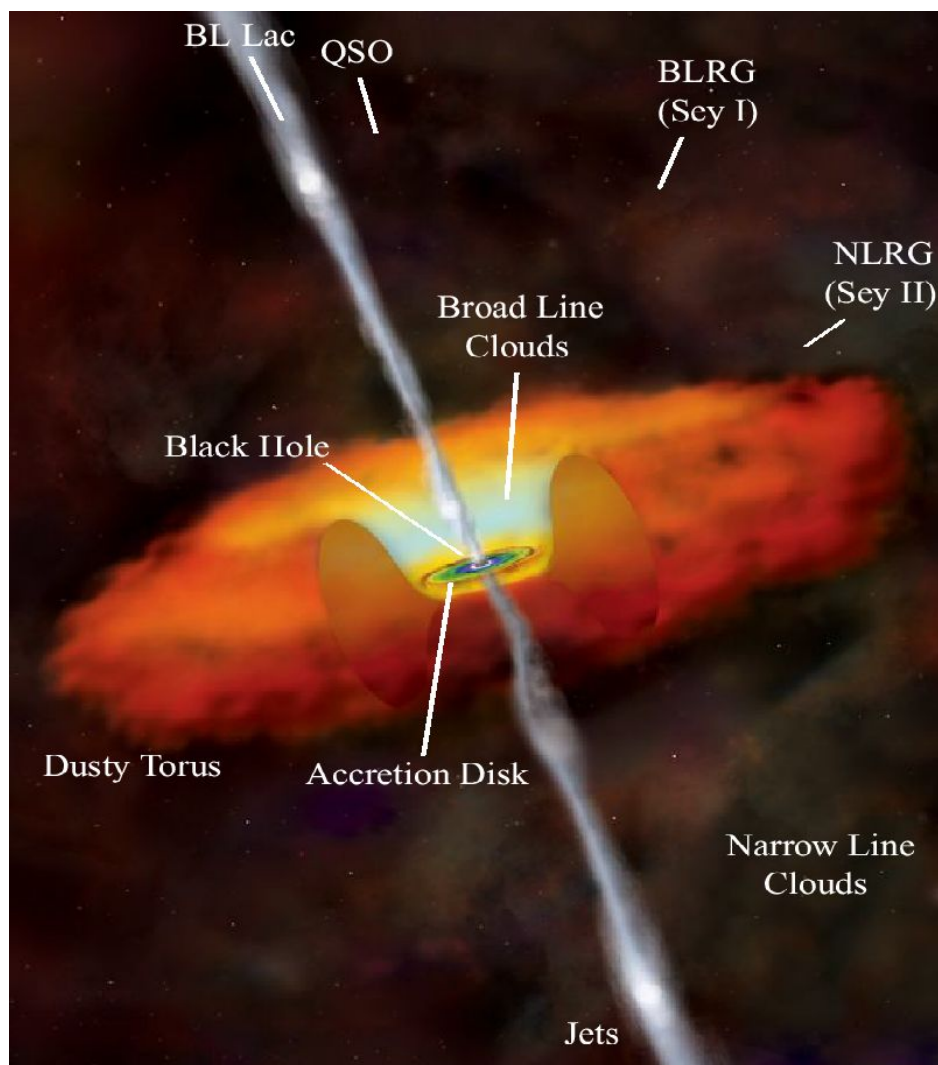
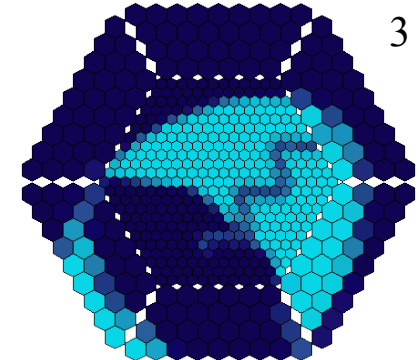


[http://integral.esa.int/integ\\_pictures.html](http://integral.esa.int/integ_pictures.html)

Multiwavelength picture in false colors



# Goal



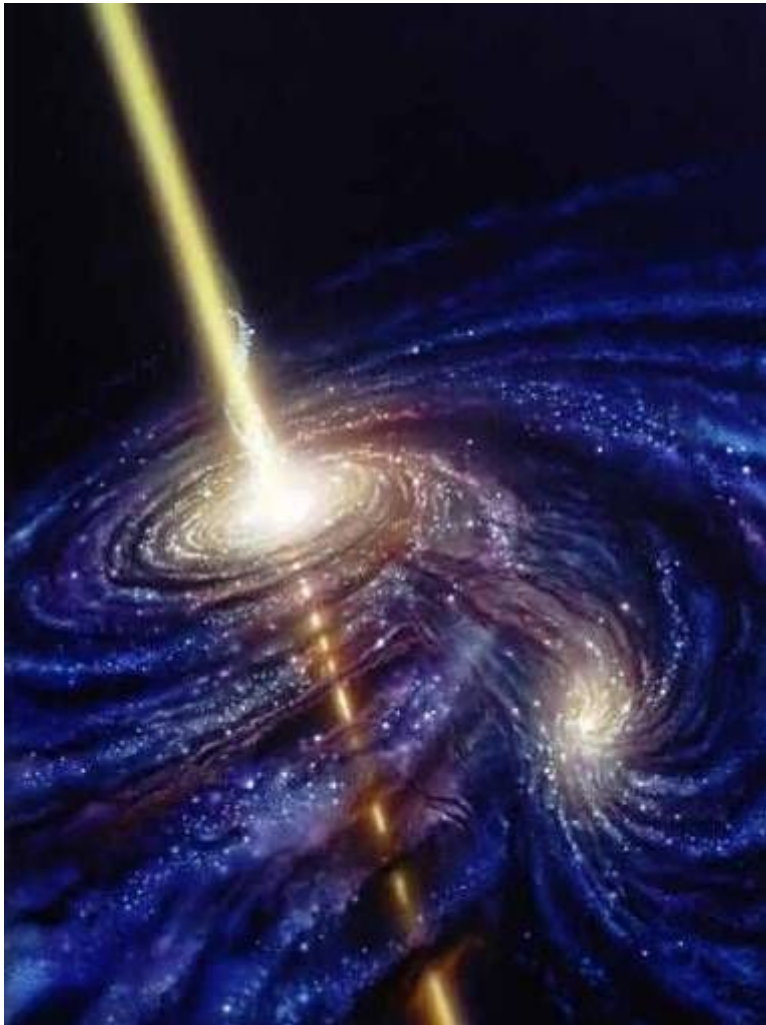
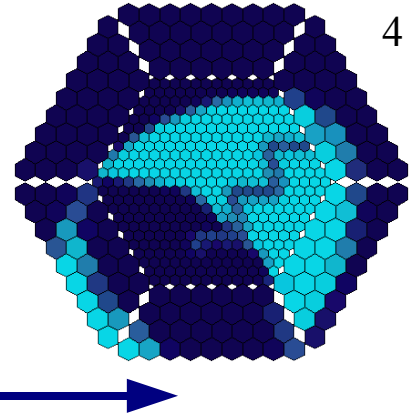
- Better understanding of acceleration mechanisms (SSC, EC, Protonblazar, etc.), i.e.
  - ➔ Short-term behaviour
  - ➔ Long-term behaviour (23d, BHB?)
  - ➔ Spectral variation/correlation
- Especially correlations with neutrinos (IceCube)
  - ➔ Clear hadronic signature!
  - ➔ ONLY possible with monitoring!

(Urry und Padovani, PASP 107, 1995)





# Goal

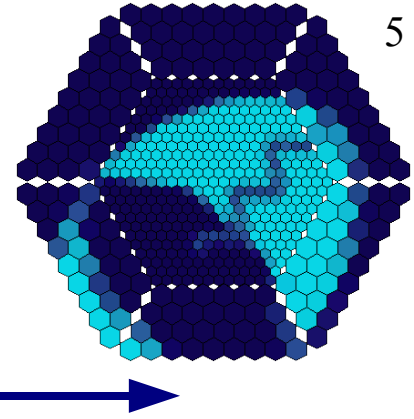


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  - ➔ Long-term behaviour (23d, BHB?)
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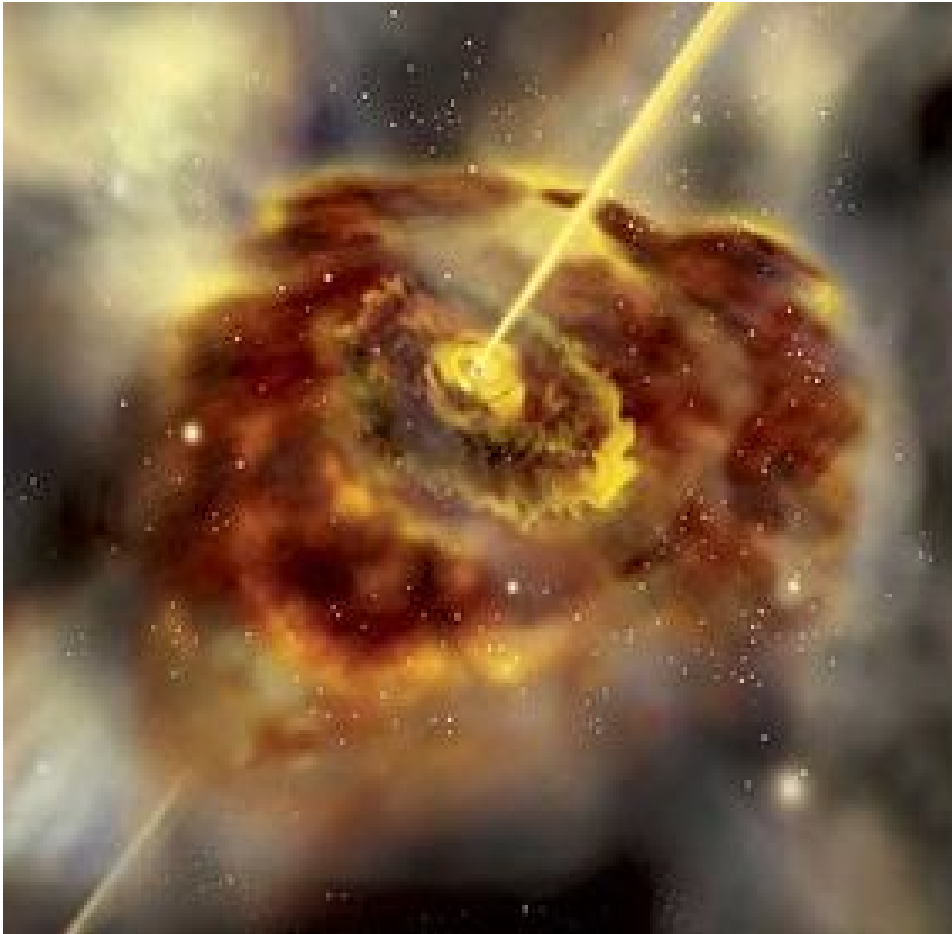
(Urry und Padovani, PASP 107, 1995)



# Goal



5

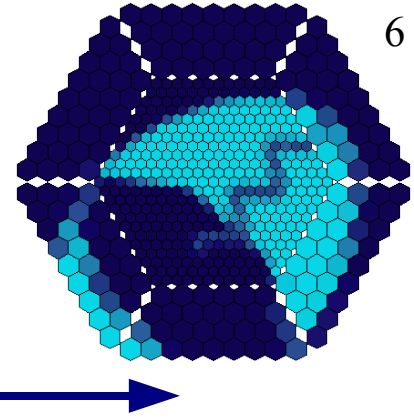


- Better understanding of acceleration mechanisms (SSC, EC, Protonblazar, etc.), i.e.
  - Short-term behaviour
  - Long-term behaviour (23d, BHB?)
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  - Clear hadronic signature!
  - ONLY possible with monitoring!

(Urry und Padovani, PASP 107, 1995)



# Goal



6

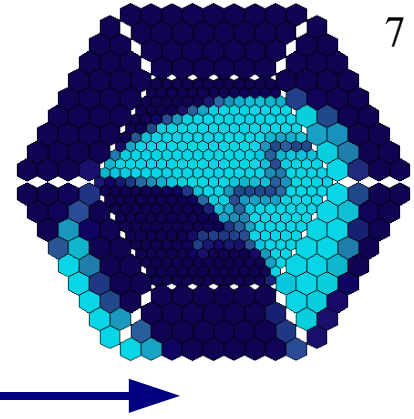


- Better understanding of acceleration mechanisms (SSC, EC, Protonblazar, etc.), i.e.
  - Short-term behaviour
  - Long-term behaviour (23d, BHB?)
  - Spectral variation/correlation
- Especially correlations with neutrinos (IceCube)
  - Clear hadronic signature!
  - ONLY possible with monitoring!

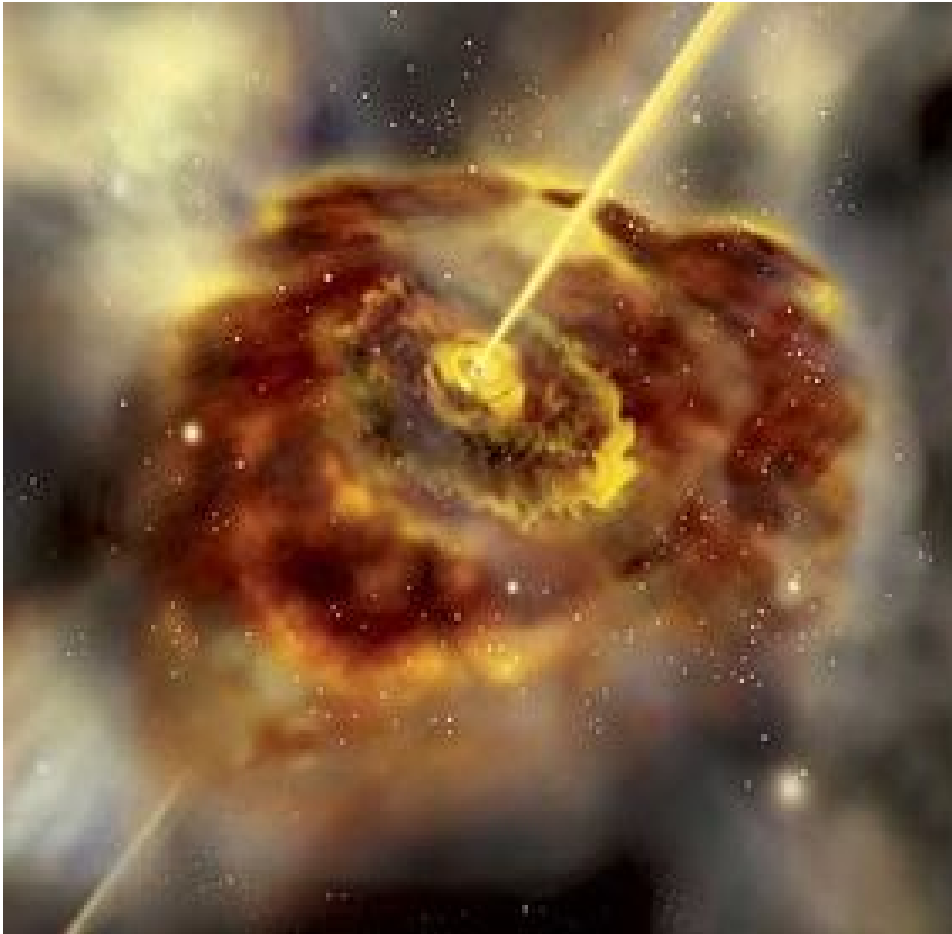
(Urry und Padovani, PASP 107, 1995)



# Goal



7

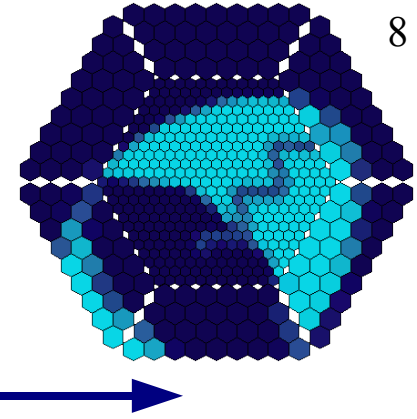


- Better understanding of acceleration mechanisms (SSC, EC, Protonblazar, etc.), i.e.
  - Short-term behaviour
  - Long-term behaviour (23d, BHB?)
  - Spectral variation/correlation
- Especially correlations with neutrinos (IceCube)
  - Clear hadronic signature!
  - **ONLY possible with monitoring!**

(Urry und Padovani, PASP 107, 1995)



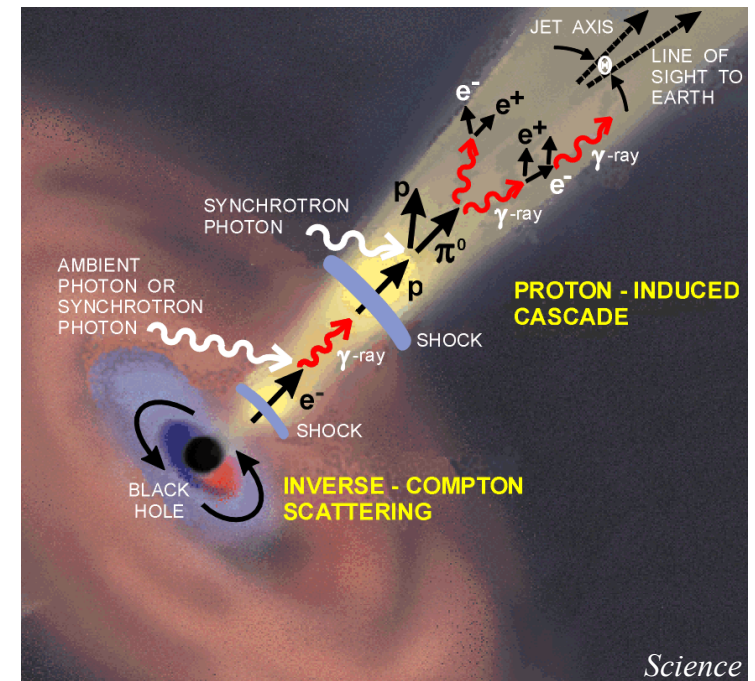
## Neutrino - correlation



- **Option 1:**  
Neutrino events trigger MAGIC

★ But: IceCube is dominated by accidental atmospheric neutrinos

➔ The trigger would be purely random

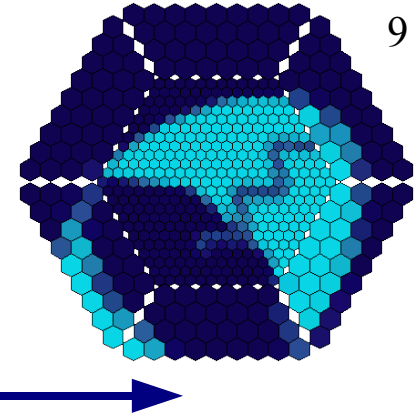


Science





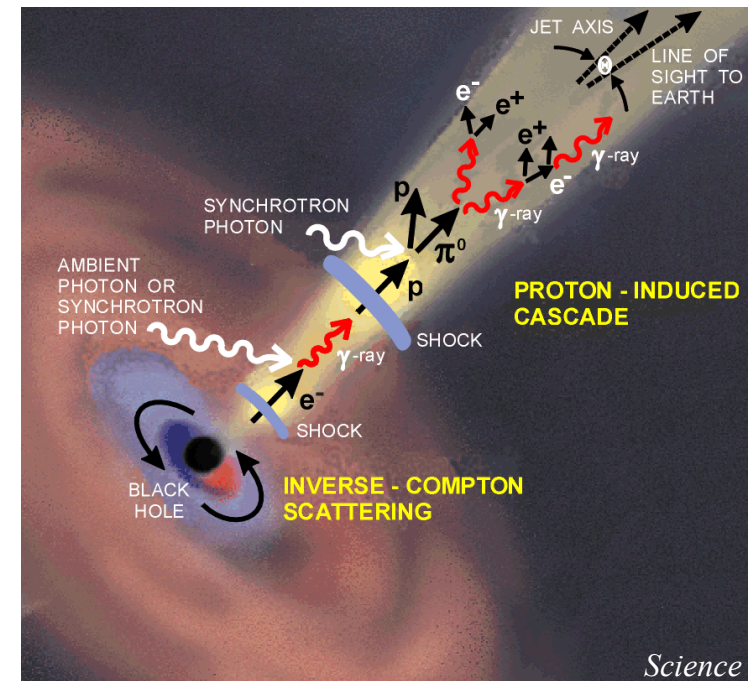
## Neutrino - correlation



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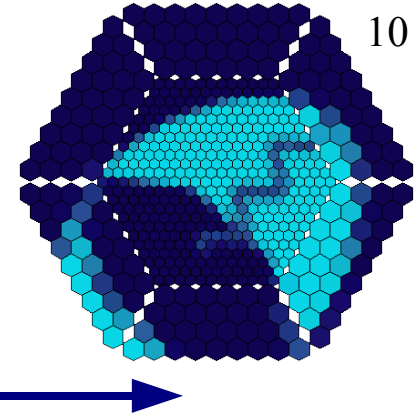
➔ The trigger would be purely random



Science



## Neutrino - correlation

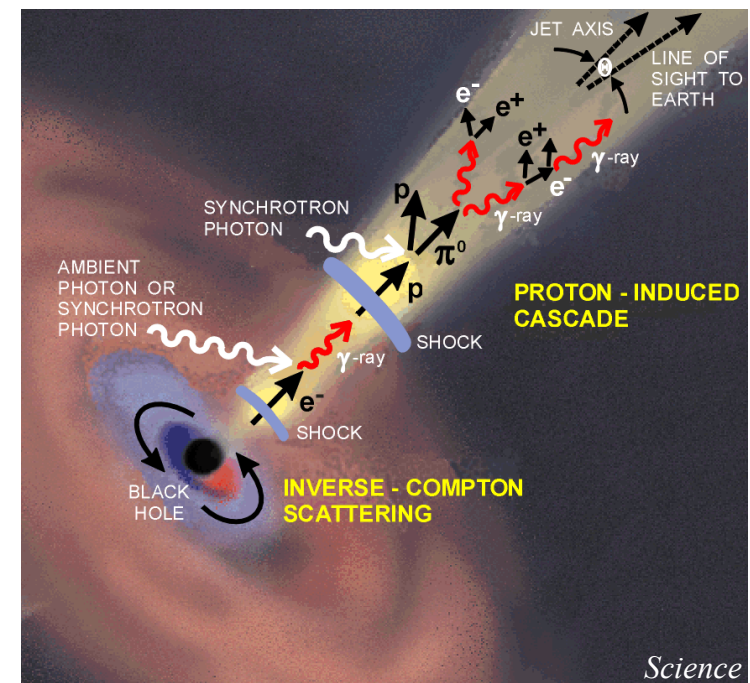


### • Option 1:

Neutrino events trigger MAGIC

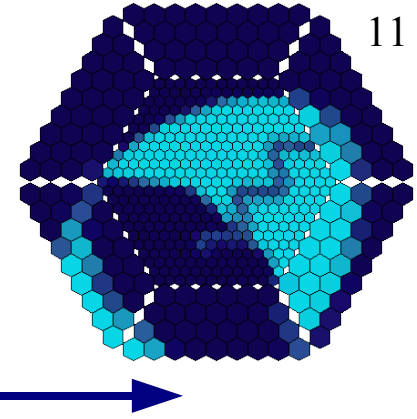
★ **But:** IceCube is dominated by accidental atmospheric neutrinos

➔ The trigger would be completely **random**





## Neutrino - correlation

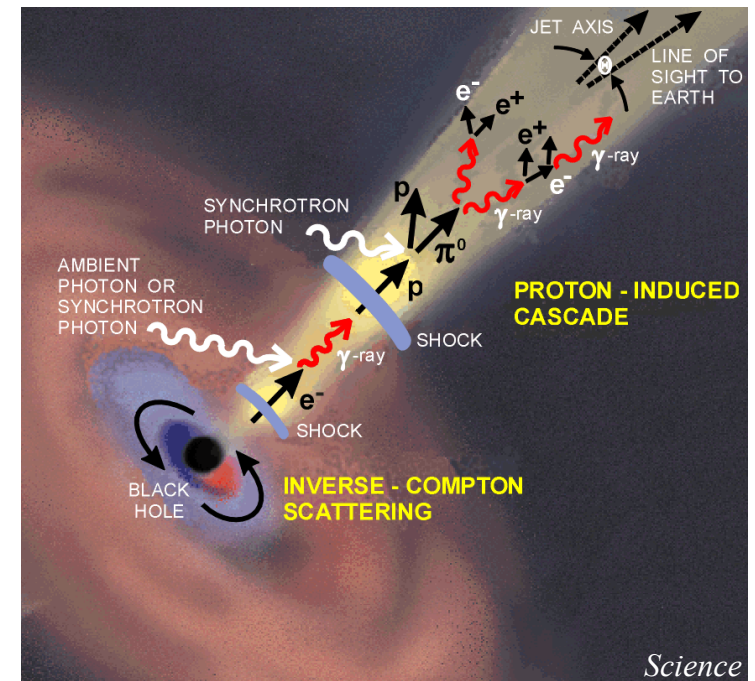


- **Option 2:**

TeV flares are used to define a time-window to look for neutrinos, i.e. to identify non-atmospheric neutrinos within the background.

★ But: IceCube is dominated by a lot of accidental atmospheric neutrinos

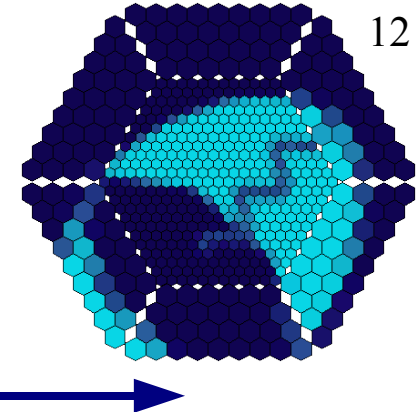
➔ The probability to find a fake signal is too high, if the flaring probabilities are unknown or the sampling is incomplete, i.e. only *flare-time* is considered.







## Neutrino - correlation

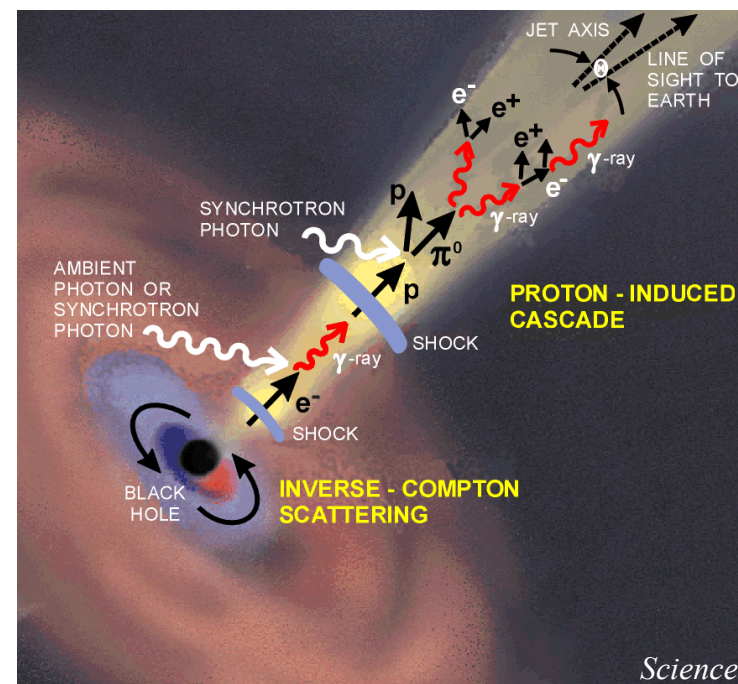


### • Option 2:

TeV flares are used to define a time-window to look for neutrinos, i.e. to identify non-atmospheric neutrinos within the background.

★ **But:** IceCube is dominated by **a lot of** accidental atmospheric neutrinos

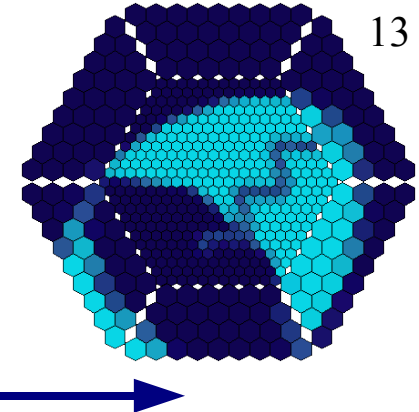
➔ The probability to find a fake signal is too high, if the flaring probabilities are unknown or the sampling is incomplete, i.e. only *flare-time* is considered.







## Neutrino - correlation

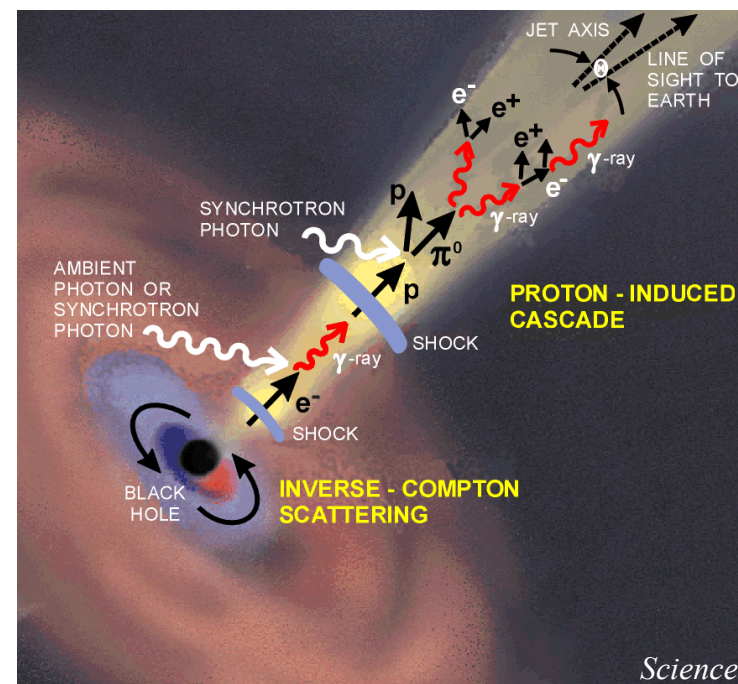


### • Option 2:

TeV flares are used to define a time-window to look for neutrinos, i.e. to identify non-atmospheric neutrinos within the background.

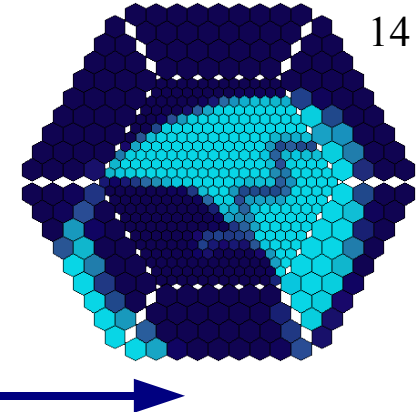
★ **But:** IceCube is dominated by **a lot of** accidental atmospheric neutrinos

➔ The probability to find a fake signal is too high, if the flaring probabilities are unknown or the sampling is incomplete, i.e. only *flare-time* is considered.





## Neutrino - correlation



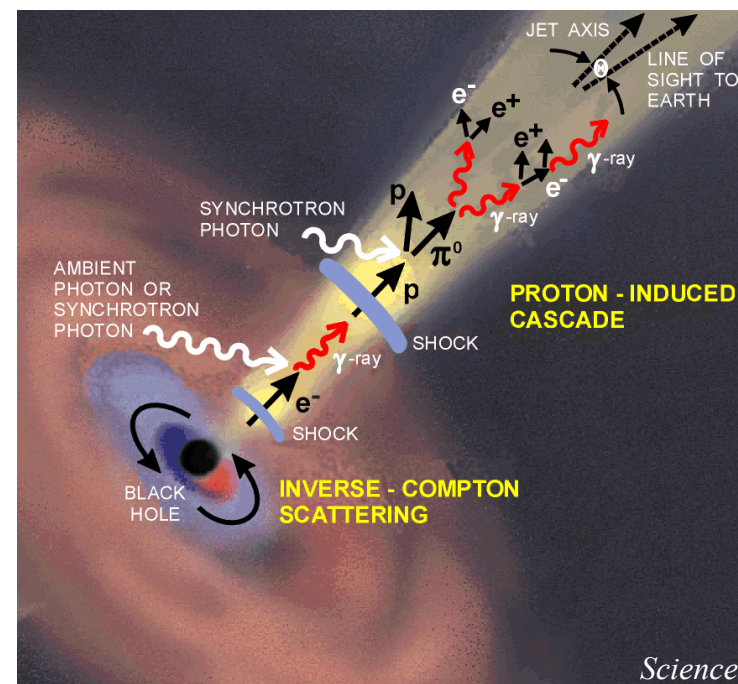
### • Option 2:

TeV flares are used to define a time-window to look for neutrinos, i.e. to identify non-atmospheric neutrinos within the background.

★ **But:** IceCube is dominated by **a lot of** accidental atmospheric neutrinos

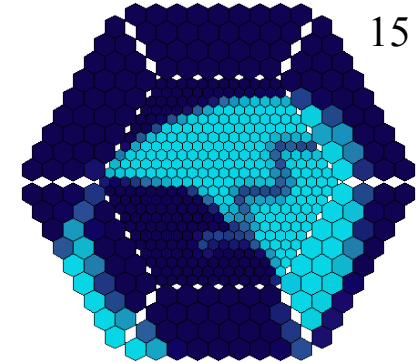
➔ The probability to find a fake signal is too high, if the flaring probabilities are unknown or the sampling is incomplete, i.e. only *flare-time* is considered.

*When is a flare a flare?*

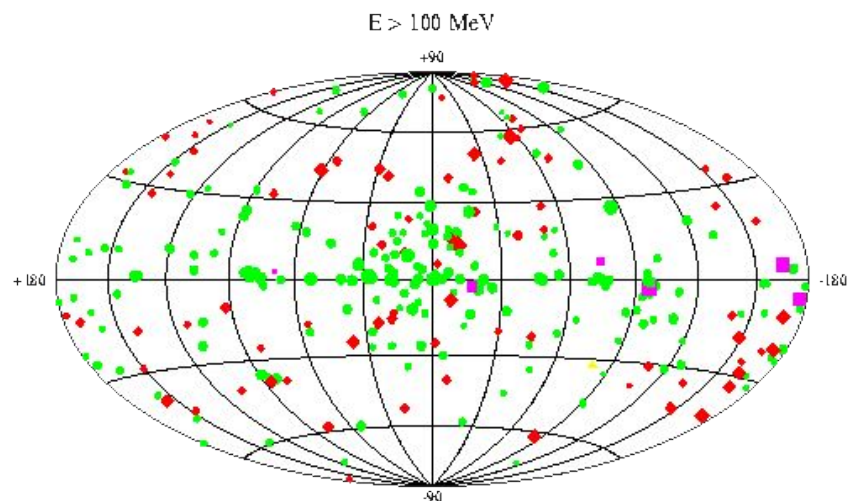




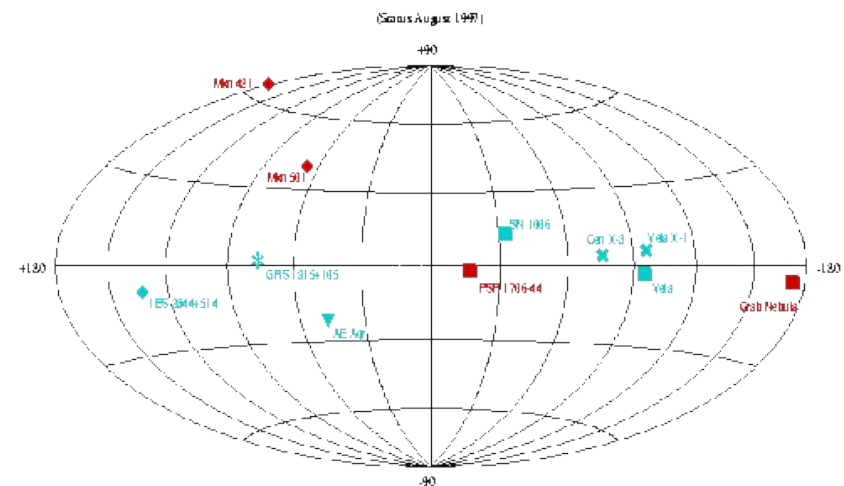
# Which source can be monitored?



THIRD EGRET CATALOGUE OF GAMMA-RAY POINT SOURCES

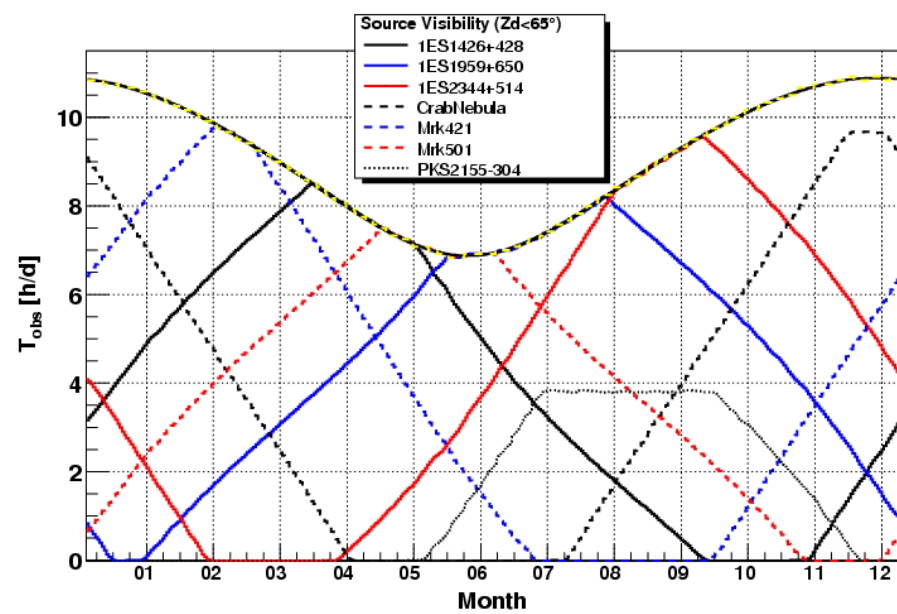


VHE Gamma Sources ( $E > 300 \text{ GeV}$ )



## Extremely bright sources:

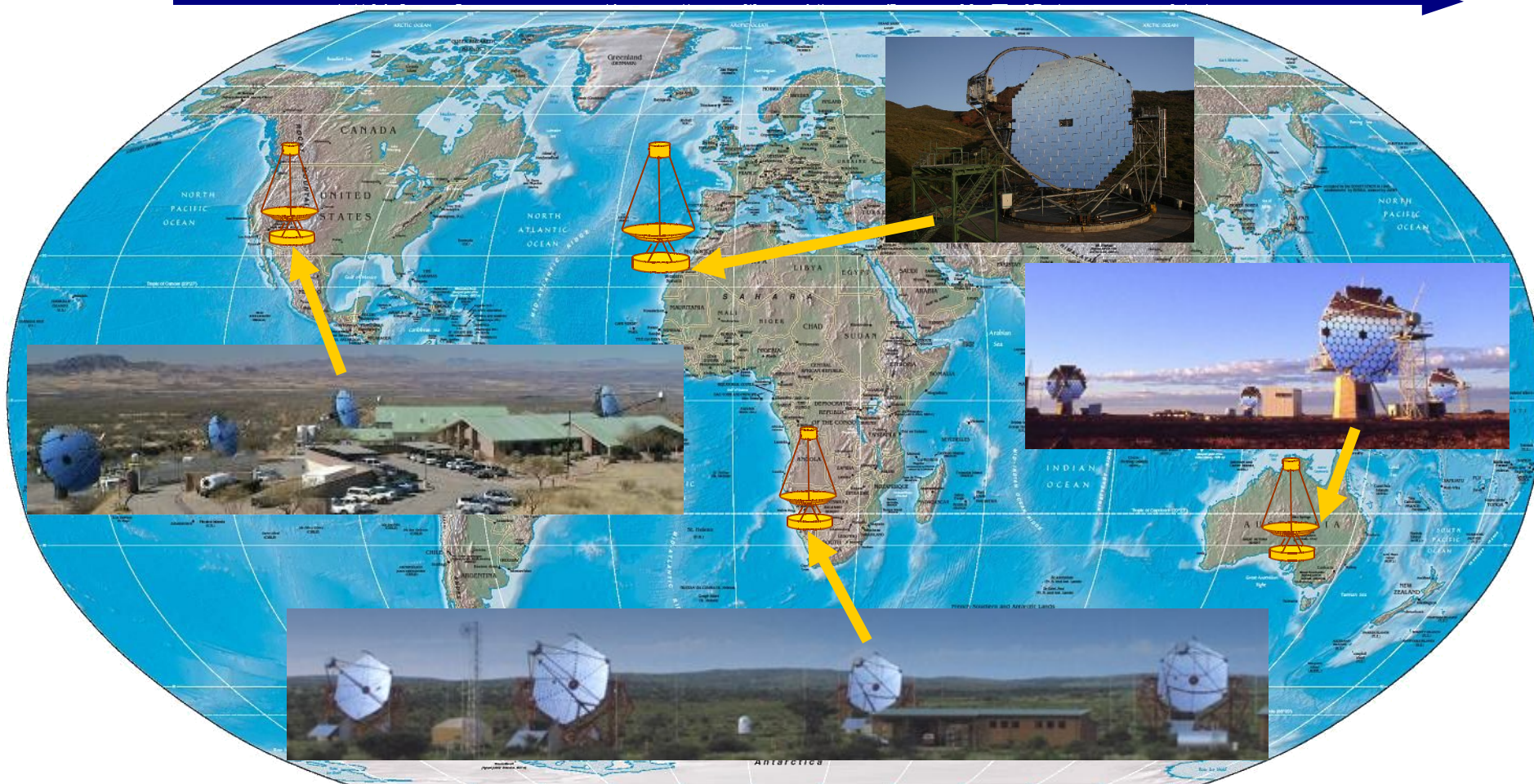
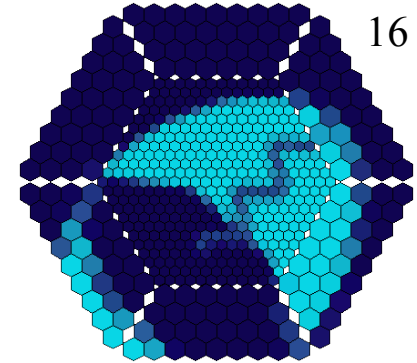
- Markarian 421
- Markarian 501
- 1ES 2344+514
- 1ES 1959+650
- H 1426+428
- PKS 2155-304







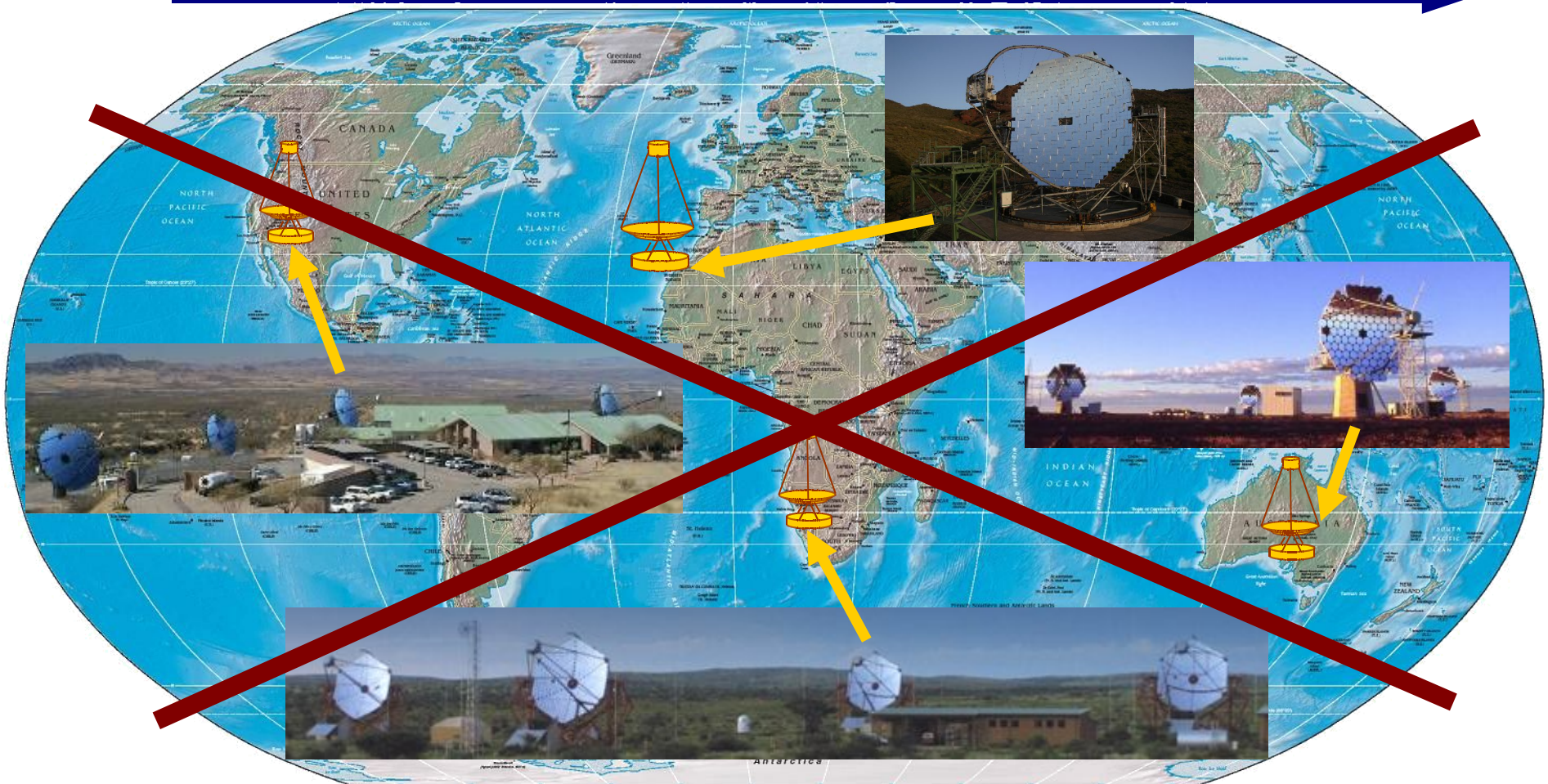
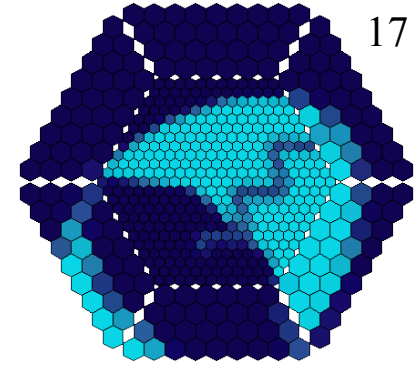
# State of the art



Low Energy Threshold/High Sensitivities



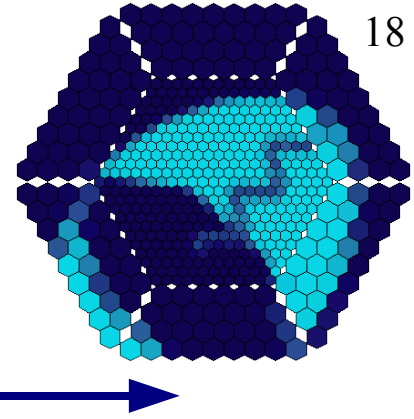
# State of the art



Low Energy Threshold/High Sensitivities  
 ==> Dedicated to *more important* observations,  
 simply too expensive for continuous monitoring



## The old HEGRA CT3 telescope



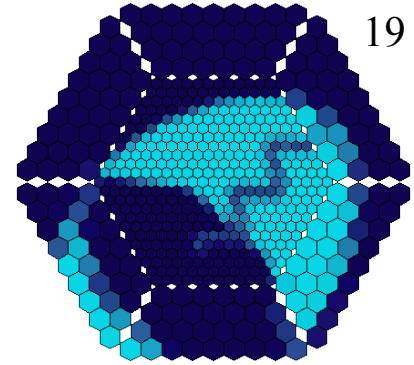
18







## The new **monitoring** telescope - DWARF

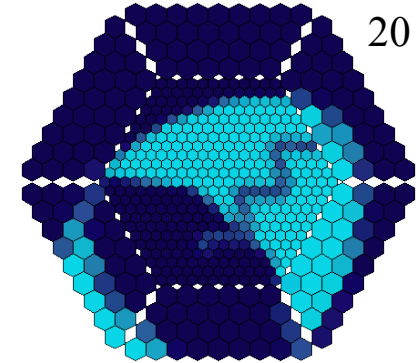


19



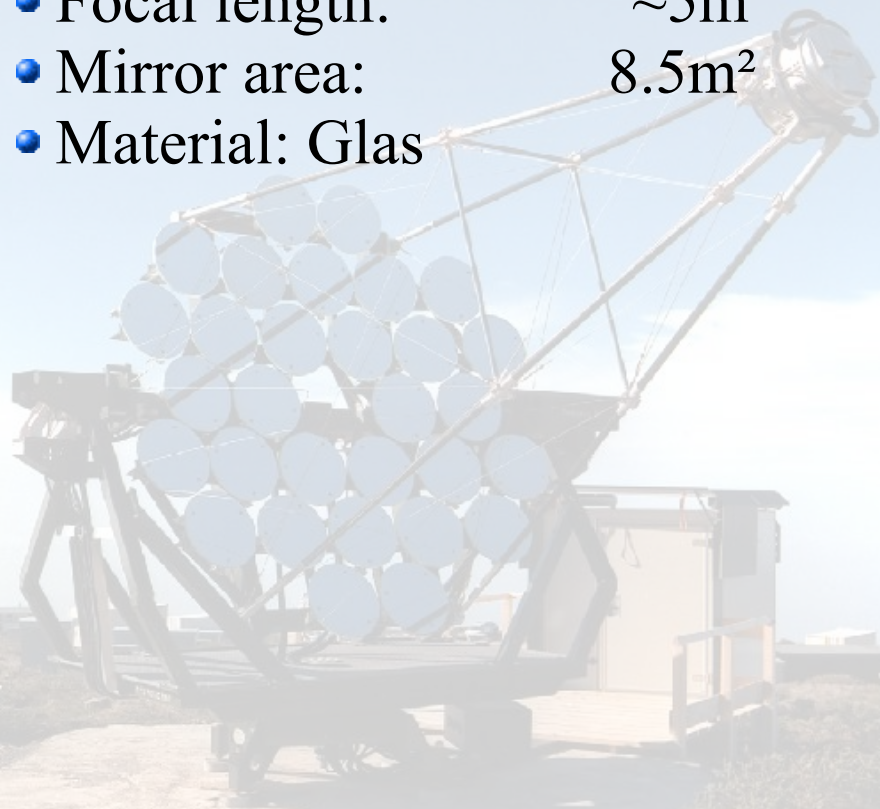


## The new **monitoring** telescope - DWARF



20

- Focal length:  $\sim 5\text{m}$
- Mirror area:  $8.5\text{m}^2$
- Material: Glas



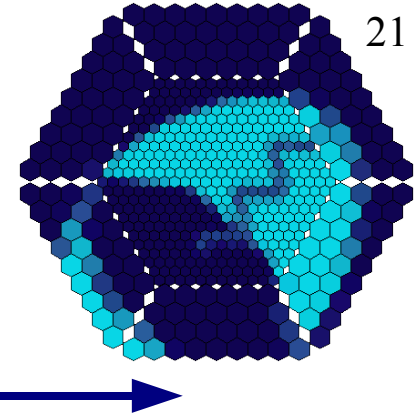
- Focal length:  $\sim 5\text{m}$
- Mirror area:  $\sim 13.5\text{m}^2$
- Material: Plastic







## The new **monitoring** telescope - DWARF



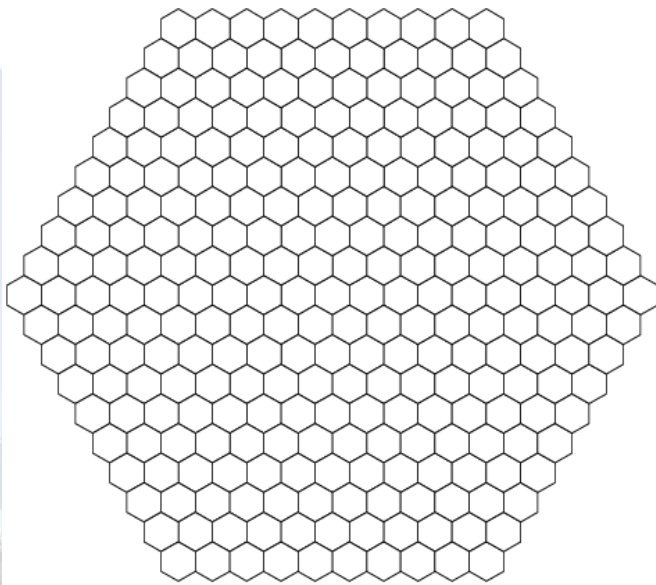
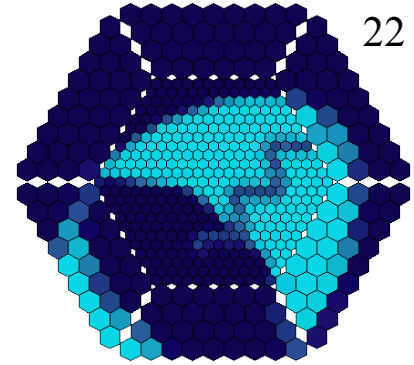
*classical!*

- Focal length:  $\sim 5\text{m}$
- Mirror area:  $8.5\text{m}^2$
- Material: Glas
- Reflectivity:  $\sim 80\%$
- Winstoncones (?):  $\sim 90\%$
- Window transm.:  $\sim 92\%$
- Field of view:  $4.3^\circ$
- QE:  $\sim 14\%$
- Operation: **manual**

- Focal length:  $\sim 5\text{m}$
- Mirror area:  $\sim 13.5\text{m}^2$
- Material: Plastik
- Reflectivity:  $\sim 90\%$
- Winstoncones:  $\sim 98\%$
- Window transm.:  $\sim 98\%$
- Field of view:  $\sim 4.5^\circ$
- QE:  $\sim 20\%$
- Operation: **fully robotic**

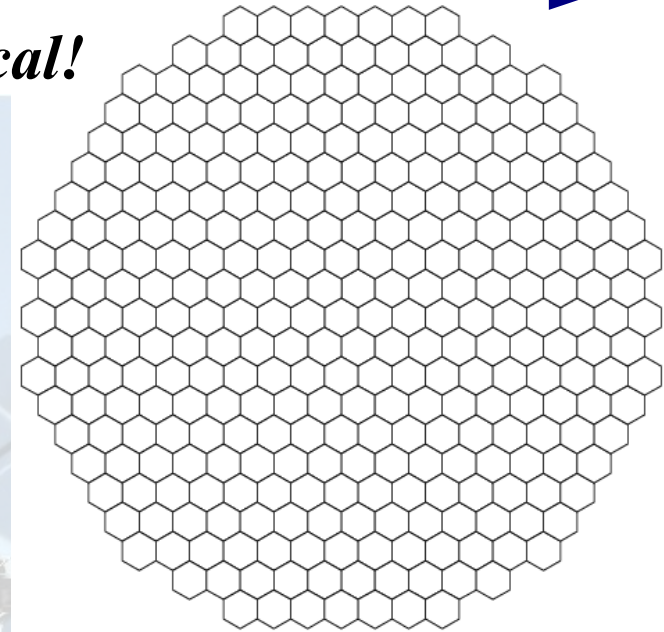


## The new **monitoring** telescope - DWARF



- 271 Pixel (hexagonal)
- Pixeldiameter:  $0.25^\circ$  (19mm)
- Triggerrate: 5Hz
- Sampling 120MHz
- DAQ extern

*classical!*

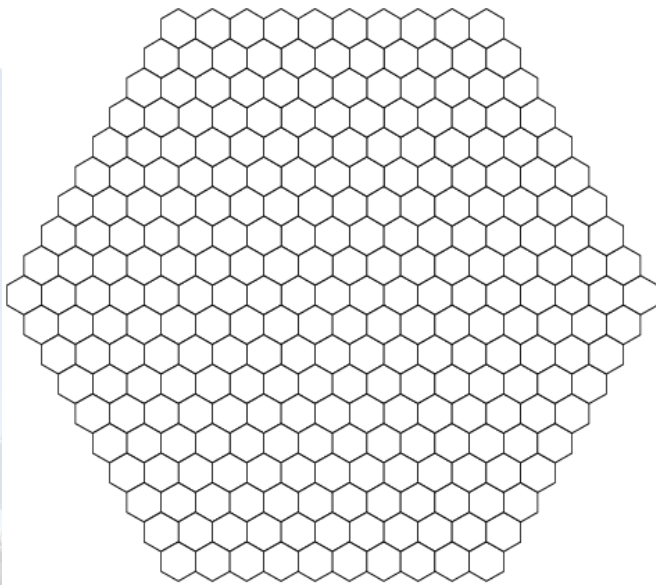
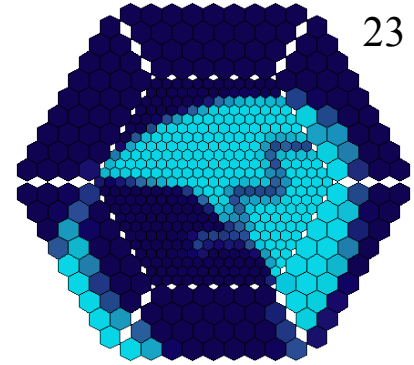


- 313 Pixel (hexagonal)
- Pixeldiameter:  $0.25^\circ$  (19mm)
- Triggerrate: 30Hz
- Sampling 1.2GHz (Domino III)
- DAQ integrated

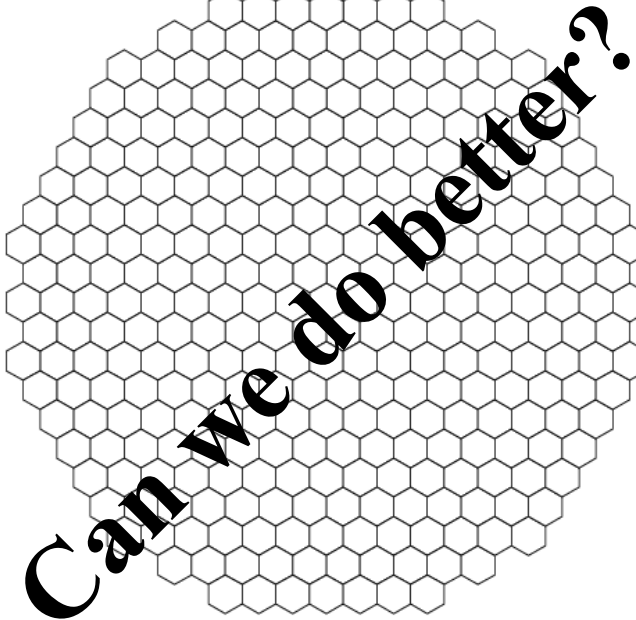




## The new **monitoring** telescope - DWARF



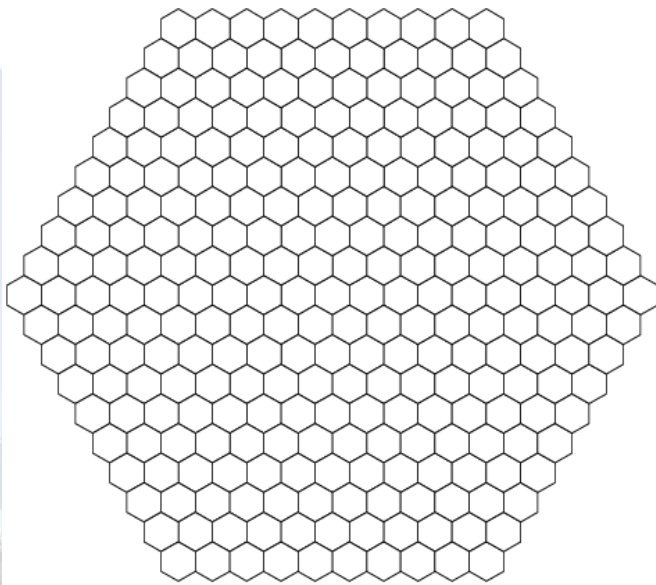
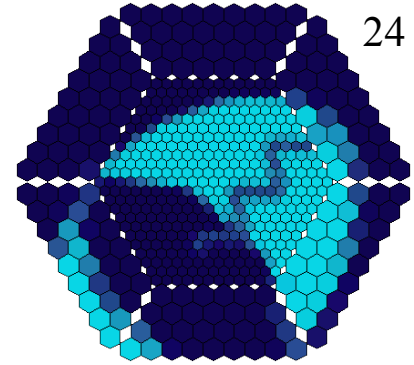
- 271 Pixel (hexagonal)
- Pixeldiameter:  $0.25^\circ$  (19mm)
- Triggerrate: 5Hz
- Sampling 120MHz
- DAQ extern



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- 271 Pixel (hexagonal)
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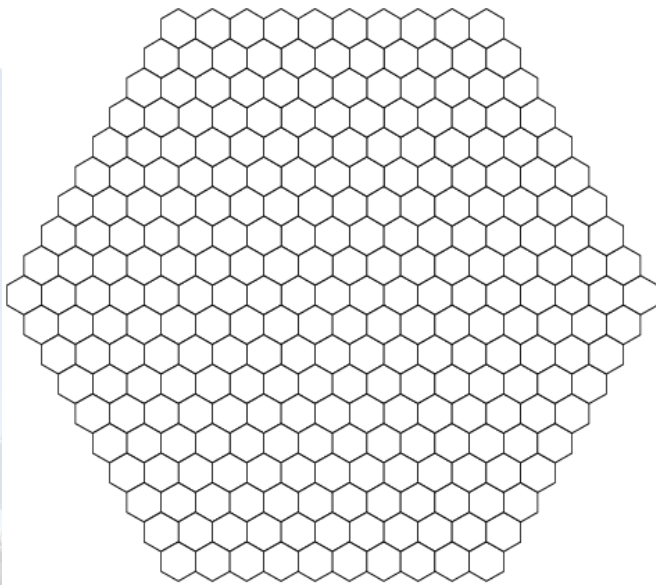
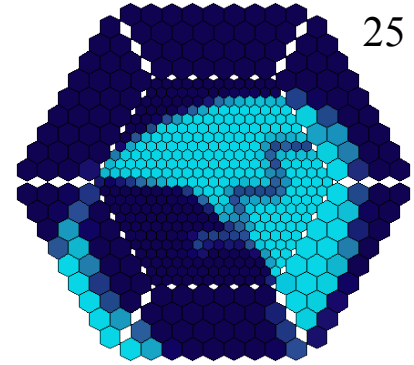


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## The new **monitoring** telescope - DWARF



- 271 Pixel (hexagonal)
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- Triggerrate: 5Hz
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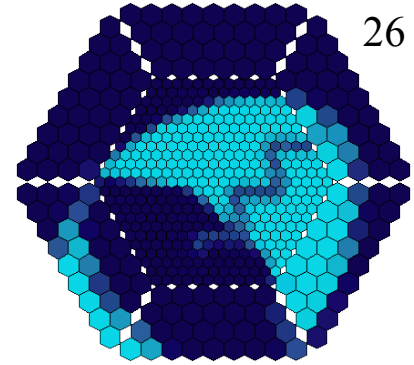


- 313 Pixel (hexagonal)
- Pixeldiameter:  $0.25^\circ$  (19mm)
- Triggerrate: 30Hz
- Sampling 1.2GHz (Domino III)
- DAQ integrated

**WHAT ELSE?**



## What can we gain from MAGIC? SOFTWARE

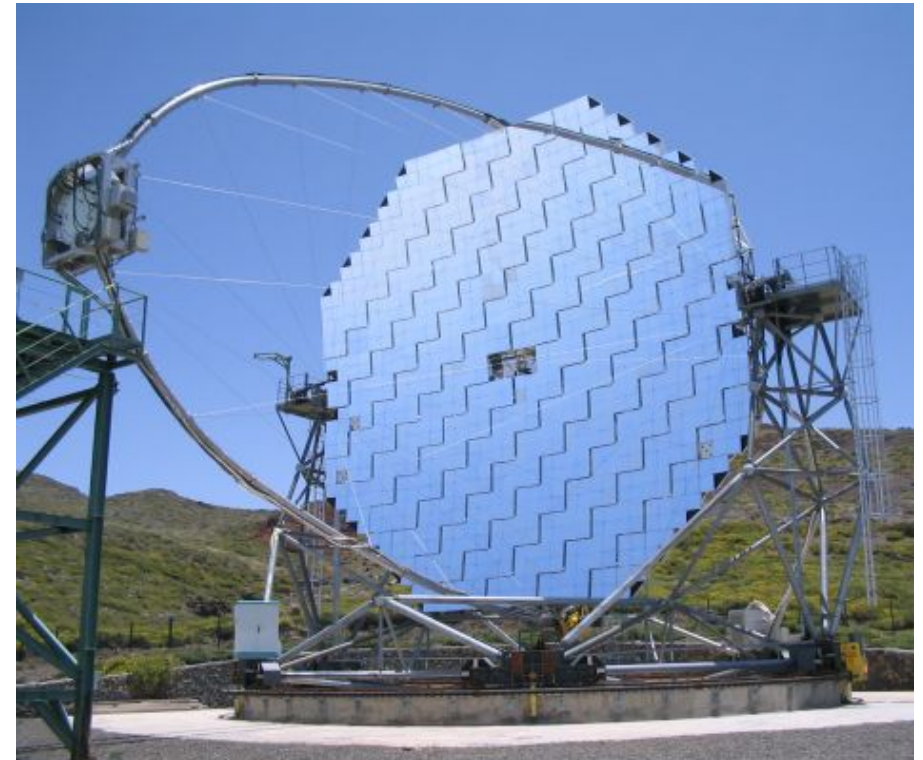


- Dataprocessing/Software

- Modular structure: **simple**

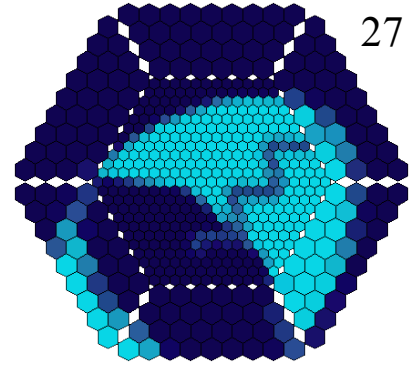
- Subsystems:

- Tracking software
  - Pointing Model
  - Starguider (tracking)





## What can we gain from MAGIC? HARDWARE

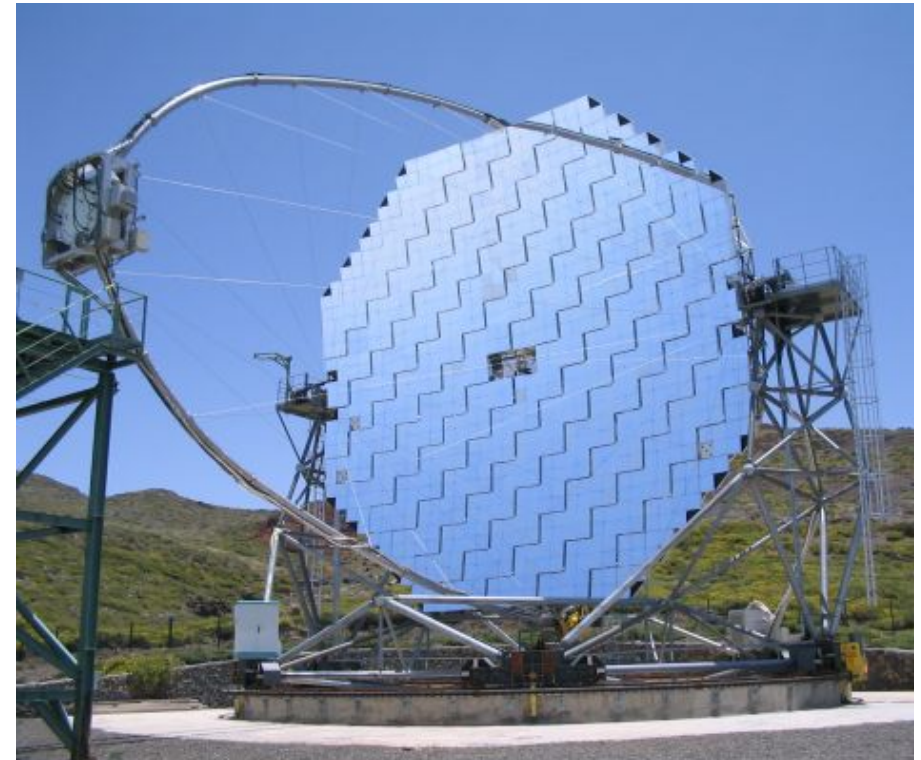


- Dataprocessing:

- **Datacenter Würzburg**  
(ca. 3TB/y)

- Subsystems:

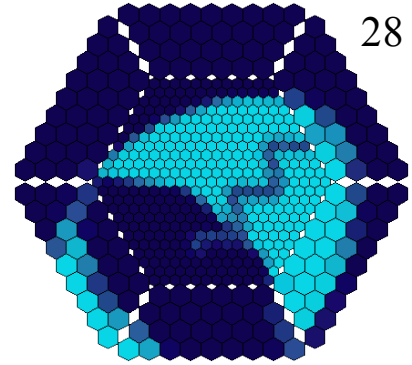
- Calibration Box
  - AMC?
  - Tracking hardware







## What can we gain from MAGIC? HARDWARE



- Dataprocessing:

- **Datacenter Würzburg**  
(ca. 3TB/y)

- Subsystems:

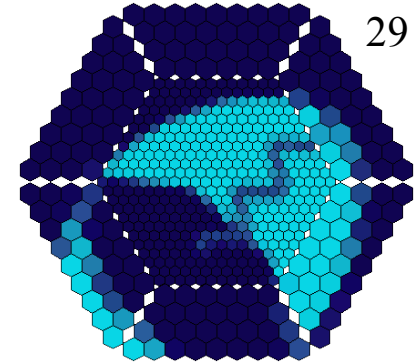
- Calibration Box
  - AMC?
  - Tracking hardware



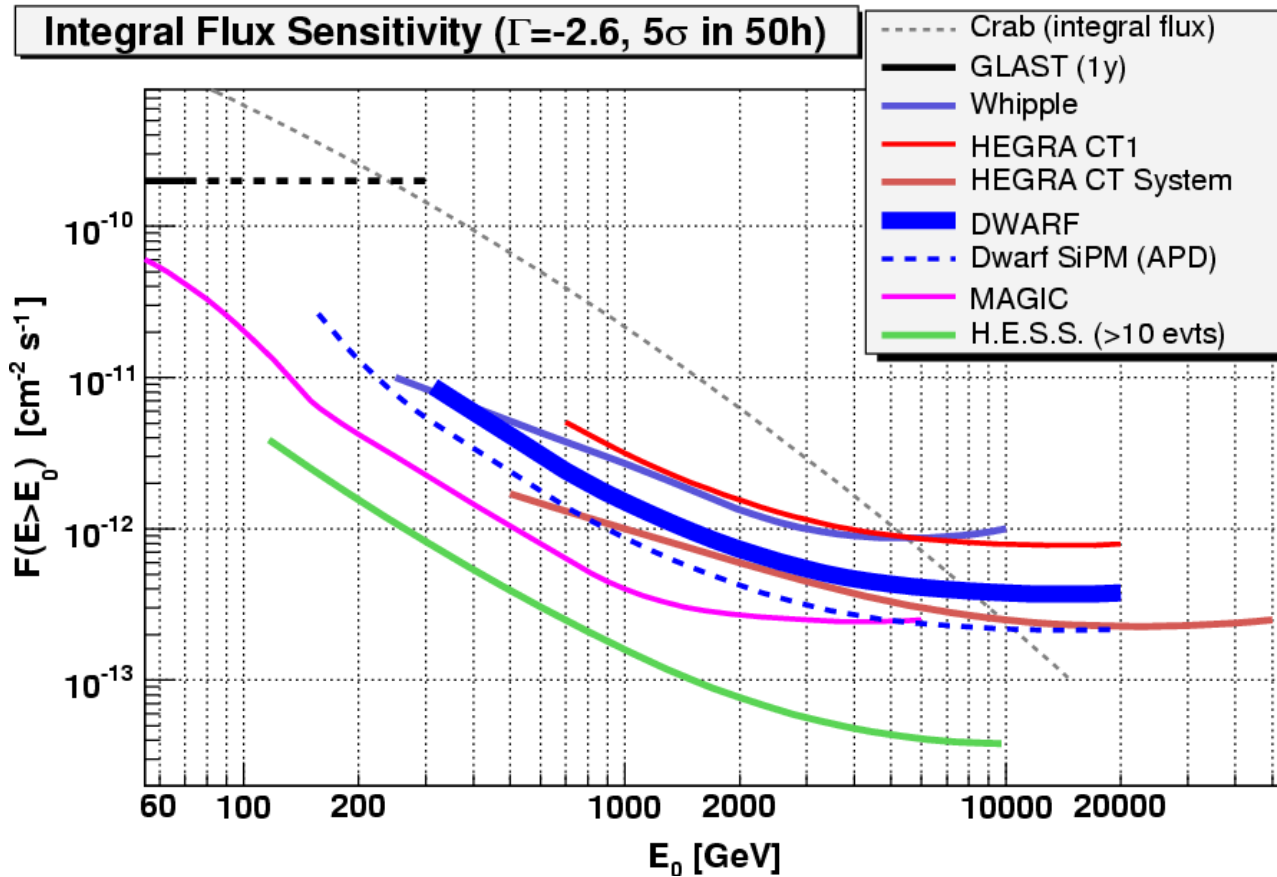




# Performance

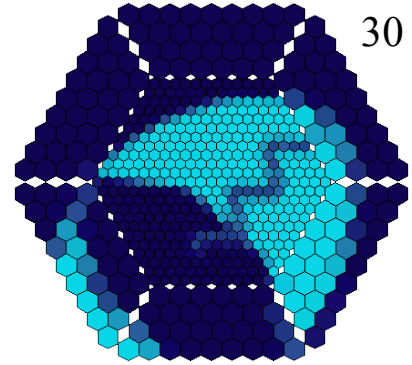


**Integral Flux Sensitivity ( $\Gamma=-2.6$ ,  $5\sigma$  in 50h)**





## STATUS



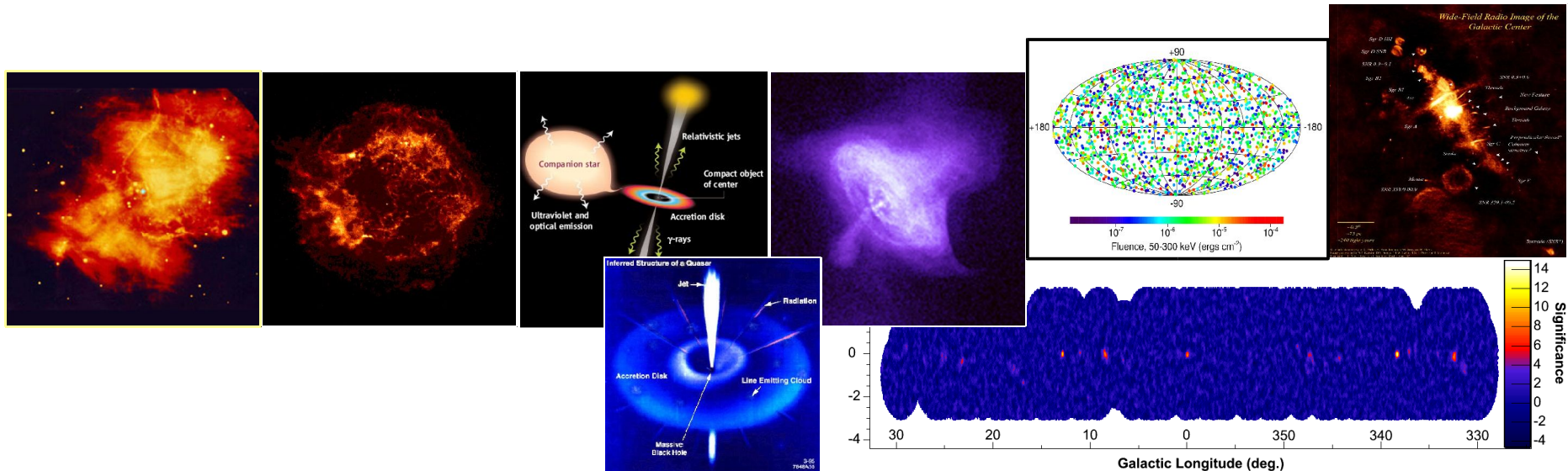
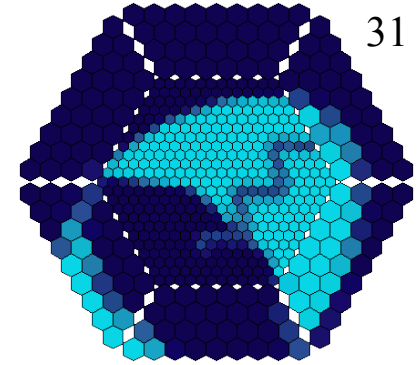
30

- Costs: ca. 350.000€  
2/3 for the camera
- Mirror prototype in production
- SPS for Tracking system ordered
- Mirror coating discussed (Fraunhofer)
- Datacenter Würzburg upgraded
- Application for DFG submitted in Dec.  
(350k€ + 2 Postdocs + 2 PhD)





# Summary

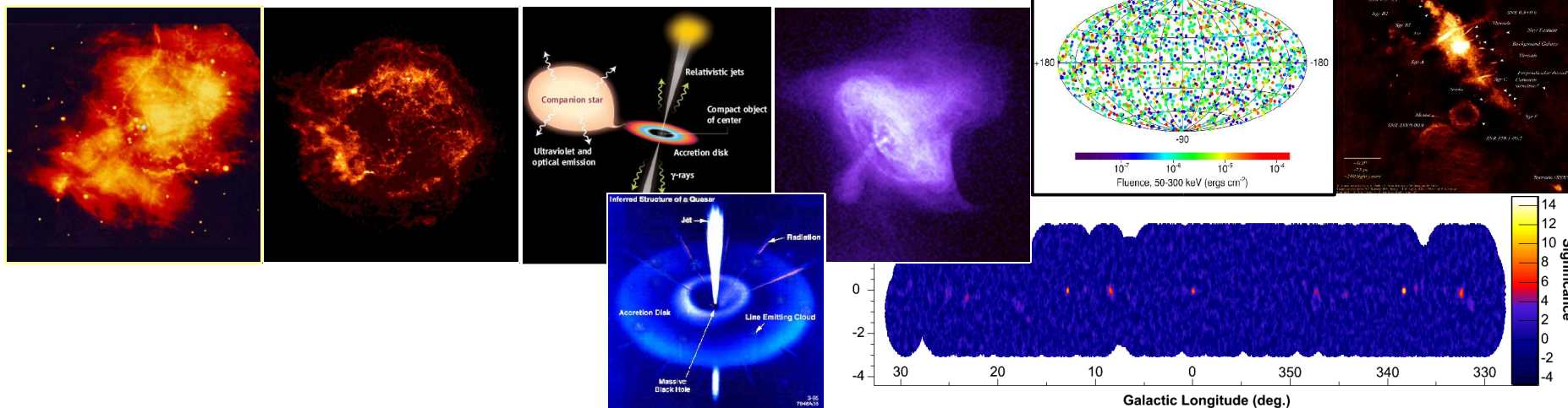
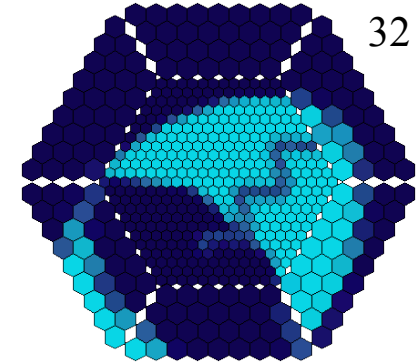


- ★ It is possible to build a cheap telescope dedicated to monitoring, which is powerfull enough to obtain proper data from long-term monitoring.
  - ➡ A camera with gAPDs seems feasible (and affordable)
  - ➡ Construction and operation can be done with only a few people
  - ➡ Robotic operation is vital. (important step towards CTA!)
  - ➡ For better resolution of flares we still can alert the other IACTs
  - ➡ First steps of the construction are ongoing





# Outlook

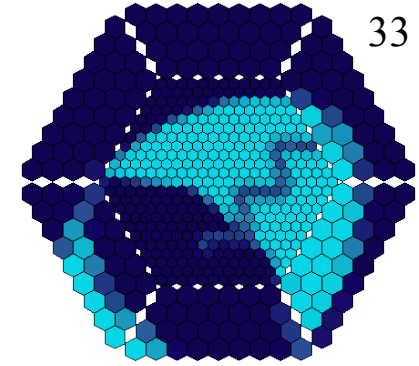


★ Long-term monitoring makes only sense if we observe in a *multiwavelength* approach.

★ Thanks a lot for the support from

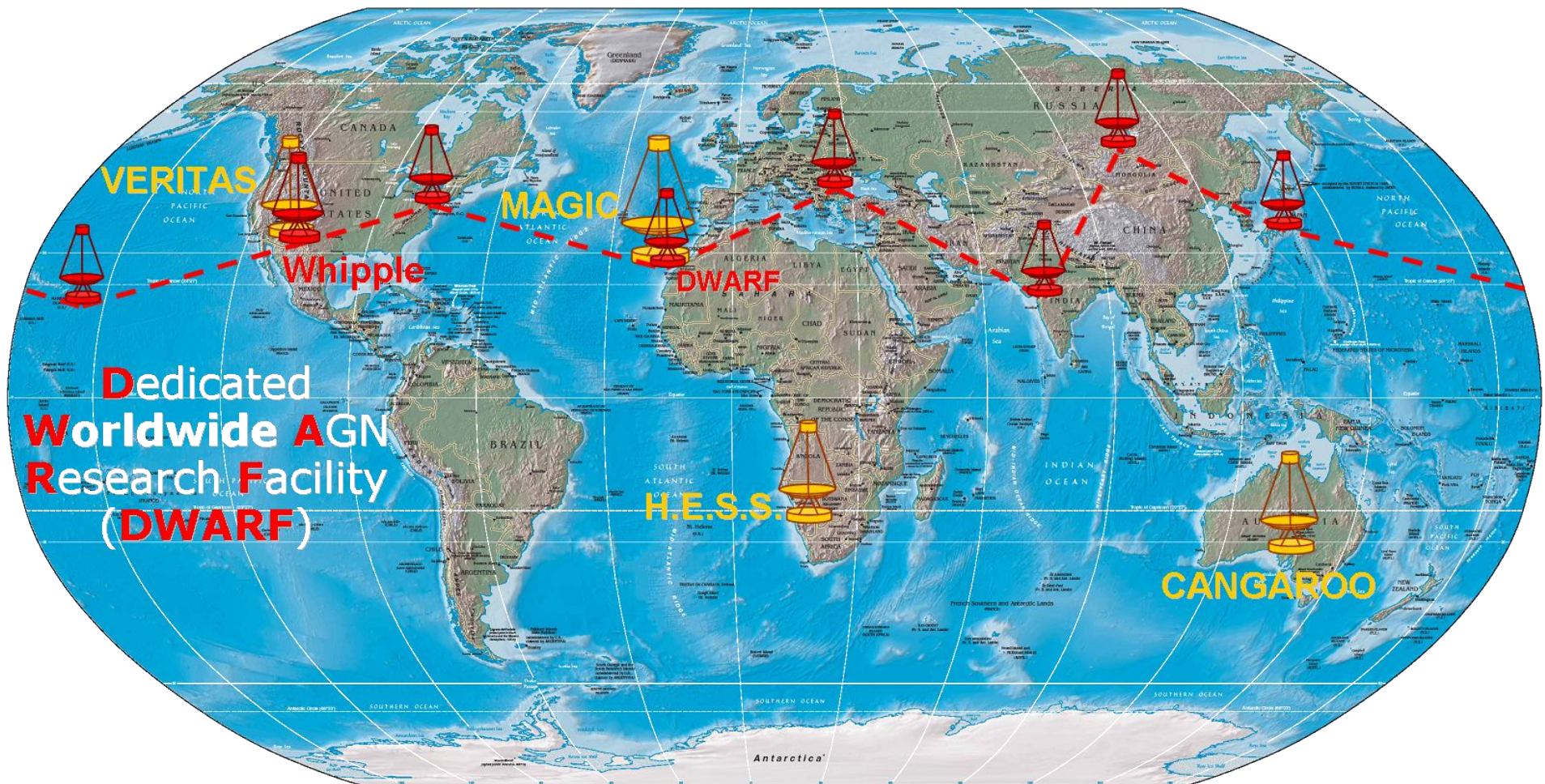
- ➡ the group of the **KVA** optical telescope
- ➡ the **Metsähovi** radio observatory
- ➡ the **MAGIC** collaboration





# Outlook

- ★ The long term goal is a **Dedicated Worldwide AGN Research Facility** to obtain a really unbiased and complete sample!





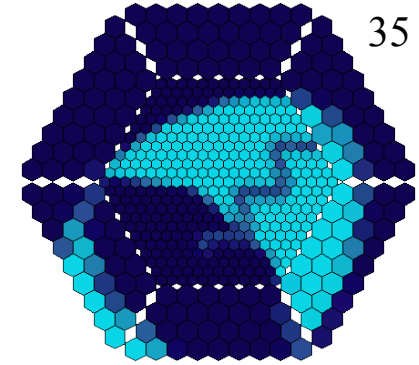
# Kiitos!



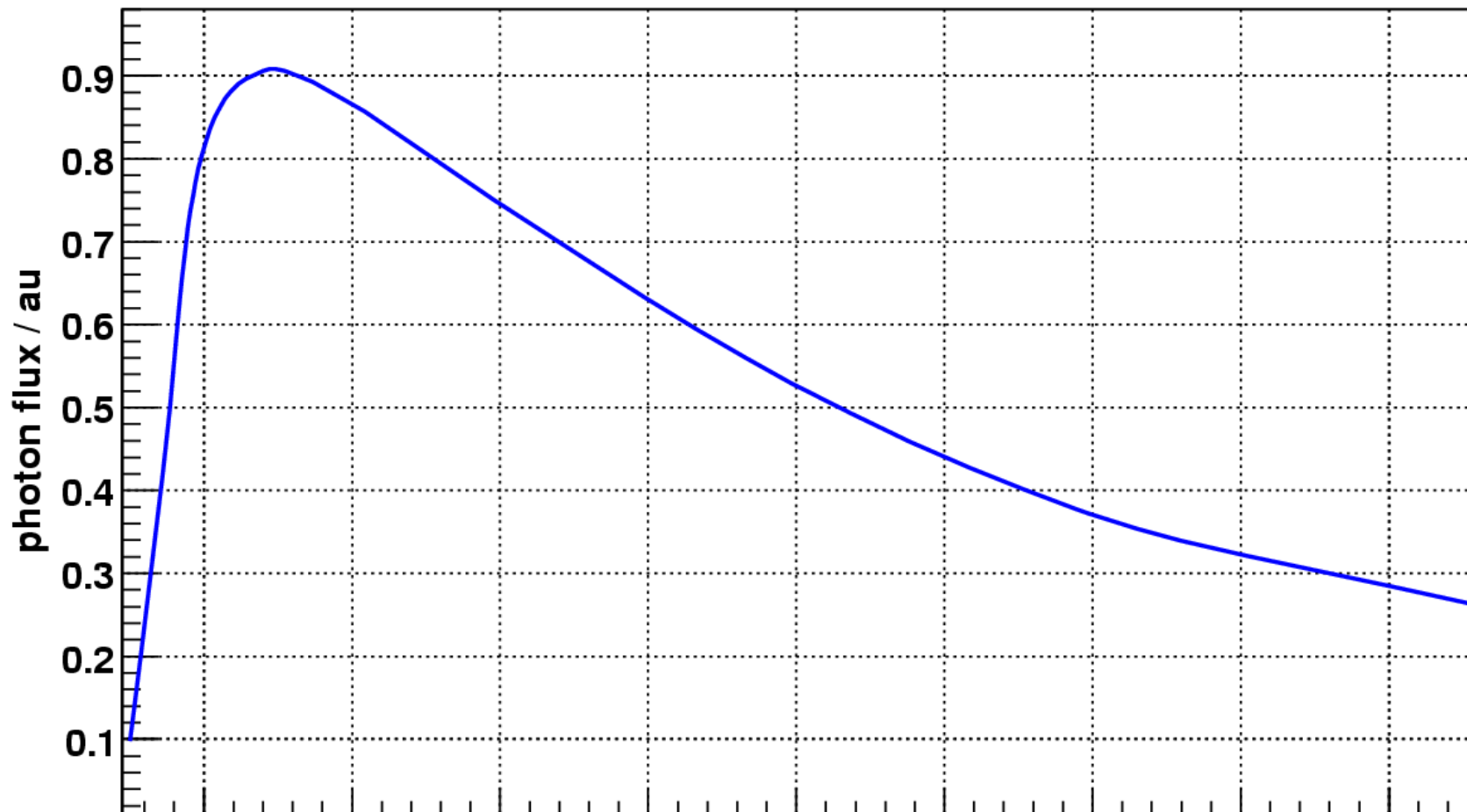




# Cherenkov spectrum

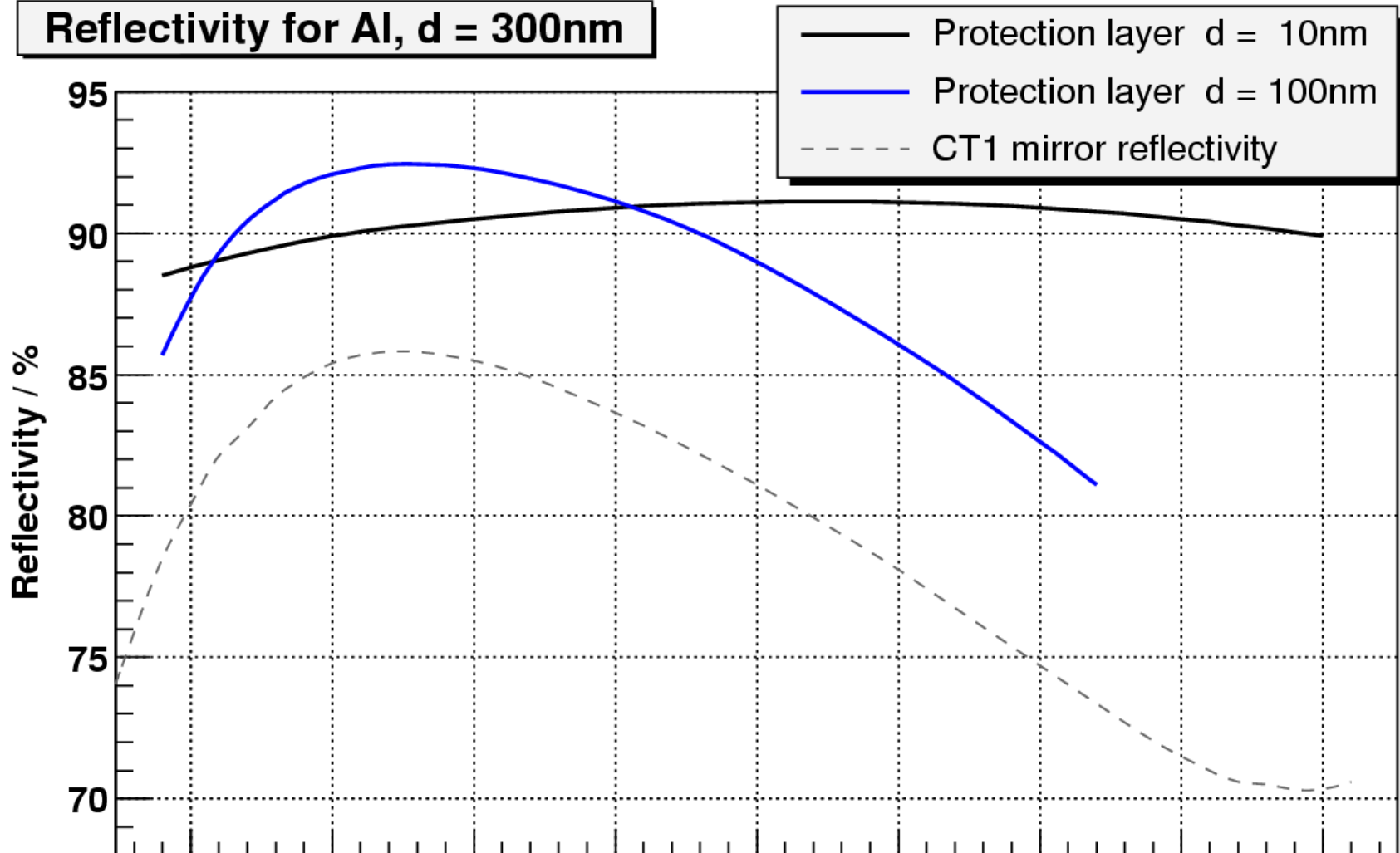
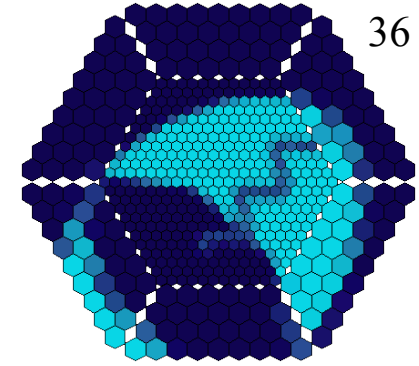


Cherenkov spectrum 2000m asl



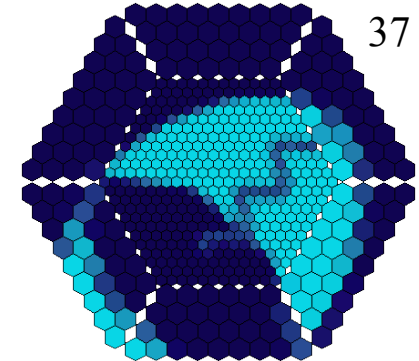


# Reflectivity

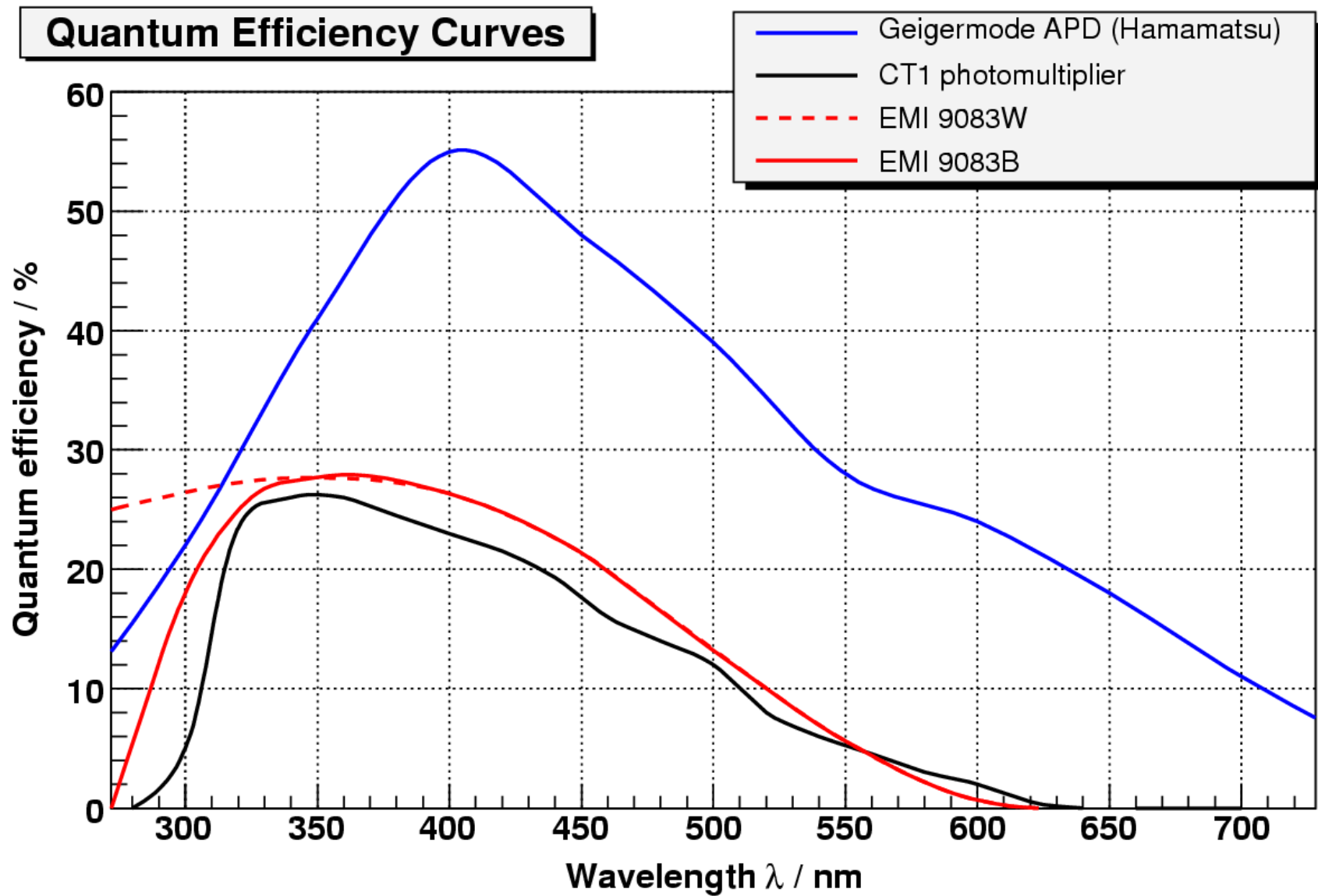




# QE



37

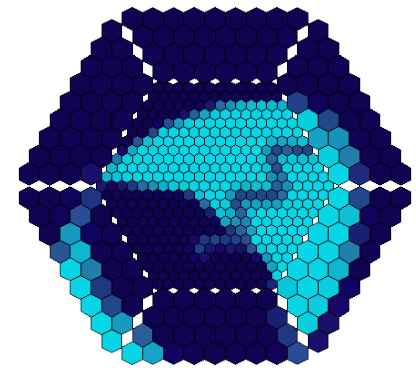






# Vielen Dank!

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**bmb+f** - Förderschwerpunkt

Astro-Teilchenphysik

Großgeräte der physikalischen  
Grundlagenforschung



**VIHKOS**

Virtuelles Institut für  
Hochenergiestrahlungen  
aus dem Kosmos

